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STATUS REPORT ON THE DESIGN OF A LIGHTWEIGHT PARATROOP BEACON

by

25X1

23 March 1951

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INTRODUCTION

This report discusses the work accomplished to date in the design of the experimental paratroop beacon following the principles outlined in the preliminary study report, dated 15 January 1951. A tentative schematic (AIL sketch 827-SF-3) of the complete equipment is enclosed.

The work on the experimental model has advanced sufficiently that a detailed discussion will be given here. The work on certain components is considered complete. On most of the other components, the work is sufficiently advanced that the design choice depends on comparing only two alternatives.

The discussion will be divided into the following headings:

1. Receiver
2. Decoder
3. Switching and Timing Circuits
4. Modulator
5. Transmitter
6. AFC
7. Antenna
8. Batteries
9. Charger
10. Test Set

1. RECEIVER

It was stated in the preliminary study report, that a sensitivity of -60 dbm would probably be attainable with a crystal-video receiver, using forward crystal bias. It has been found that -50 dbm is attainable with no bias. To obtain the additional 10 db of sensitivity, it is necessary to place the low-frequency cut-off of the video amplifier at about 0.5 megacycles. This leads to an oscillatory response to a video pulse. Such a response may be usable; however, further testing will be required to determine the special requirements resulting from the oscillatory response.

For the video amplifier, it has been found satisfactory to use five CK544DX sub-miniature low-drain pentodes.

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2. DECODER

The prf decoder has been found to be satisfactory with respect to prf discrimination; however, a minimum of about forty pulses is required for unlocking. This slow response limits the scanning speed for unlocking to about two to four rpm for 1.5 to 3.0 degree beamwidths respectively.

Other circuits will be studied in an effort to increase the operating speed by at least three to one. On the other hand, a very slow response adds to the security against accidental triggering.

3. SWITCHING AND TIMING CIRCUITS

Satisfactory switching and timing circuits have been studied. Long-time-constant R-C circuits and very-low-drain subminiature tubes will be used for timing to obtain the necessary delay in turning on the modulator and to hold the transmitting section on until five minutes after the last interrogation. Large resistance values associated with these circuits will necessitate hermetic sealing of the timing networks.

4. MODULATOR

Two modulator tube types show promise of being satisfactory, the 2D21 and the 5696. The 2D21 is capable of controlling the required input pulse power for a degaussed QK-299 or a standard 2J41, but has a 6.3 volt, 0.6 ampere heater, which would be the major portion of the battery drain. From preliminary tests, it is believed that two 5696 tubes will also be capable of controlling the required power. If so, the heater drain will be cut by one half to 6.3 volts at 0.3 ampere, increasing filament battery life during transmission by thirty percent.

Germanuim crystals, type 1N39, have been found suitable as charging diodes and as by-pass diodes, thus eliminating heater current drain and high voltage switches in these circuits.

Forward bias of 400 volts on the magnetron is being considered to reduce the modulator power requirements.

Protection of the modulator components by the use of an over-current relay has been found satisfactory. To permit the network voltage to rise to its maximum value before the transmitter is fired a circuit which utilizes a thyratron blanking voltage derived from the network charging voltage is being studied.

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5. TRANSMITTER

The QK-299 magnetron has been tested and appears to be a reliable type. Its power capabilities, and therefore input power are somewhat higher than necessary for satisfactory beacon operation. Tests have been made at reduced magnetic field strength to determine the possibility of operating at lower power inputs and thus reducing the size of the thyratron required. Satisfactory operation has been obtained at minimum modulator pulse inputs of 2.8 KV at 0.6A instead of 3.8 KV at 0.5A. In both cases, the minimum r-f power output is approximately 400 watts.

The characteristics of the 2J41 magnetron appear on paper to be better in several respects than those of the QK-299. It has satisfactory built-in stabilization; the QK-299 requires AFC. It is capable of operating at lower power than the QK-299, thus reducing the size of the required thyratron. However, the 2J41 is currently out of production, and no samples have been obtainable for testing.

6. AFC

To reduce the power required to obtain automatic frequency control for the QK-299, tests are going to be made on a search-and-stop tuning device utilizing a thermally stable reference cavity. In general the problem of mechanical AFC on a low duty ratio device, such as this beacon, is difficult, necessitating very rapid and tight actuation. In this respect the 2J41 is superior inasmuch as cavity stabilization is satisfactory for beacon operation. A frequency tolerance of ± 2 Mc is being considered adequate.

If the simple frequency control does not prove satisfactory tests will be made on more complex servo-type AFC schemes. At this time, however, there do not seem to be any servo AFC's that are economical of battery drain, bulk, and weight.

A strong argument in favor of using the 2J41 magnetron is the fact that it requires no AFC.

7. ANTENNA

The antenna is not being studied experimentally. It is anticipated that an APN-11 antenna, modified slightly for ground operation, will be satisfactory for this beacon.

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8. BATTERIES

The Yardney "Silvercel" battery has been tested in a cold chamber and found to be satisfactory in that the electrolyte did not freeze at -60° F. A rise in the internal resistance of the battery was the only observed effect. The open-circuit voltage did not change appreciably.

The rise in internal resistance can be tolerated provided a large capacitor is used across the battery to obtain smoothing action.

The recharge characteristics of the cells are such that high charge rates do not damage them. The discharge voltage curve is quite flat at 1.5 volts until the discharge is nearly complete. This type of discharge characteristic is superior to that of the LeClanche cell which is characterized by a continuous voltage droop from the beginning of the discharge. The "Silvercel"s can be stored either charged or discharged without damage.

9. BATTERY CHARGER

No tests have been made on battery chargers; however, it is expected that a very simple rectifier using selenium rectifiers can be made to operate from almost any ordinary ac power source. The possibility of leaving the charger connected during operation is being considered. Where the location permits this type of operation, the operating life should no longer be dependent on battery life, and at the same time loss of a-c power would not stop the operation of the beacon.

10. TEST SET

A simple test set consisting of an X-band cavity excited by a buzzer resonant at the chosen prf will be tested in an attempt to keep the test set complexity at a minimum.

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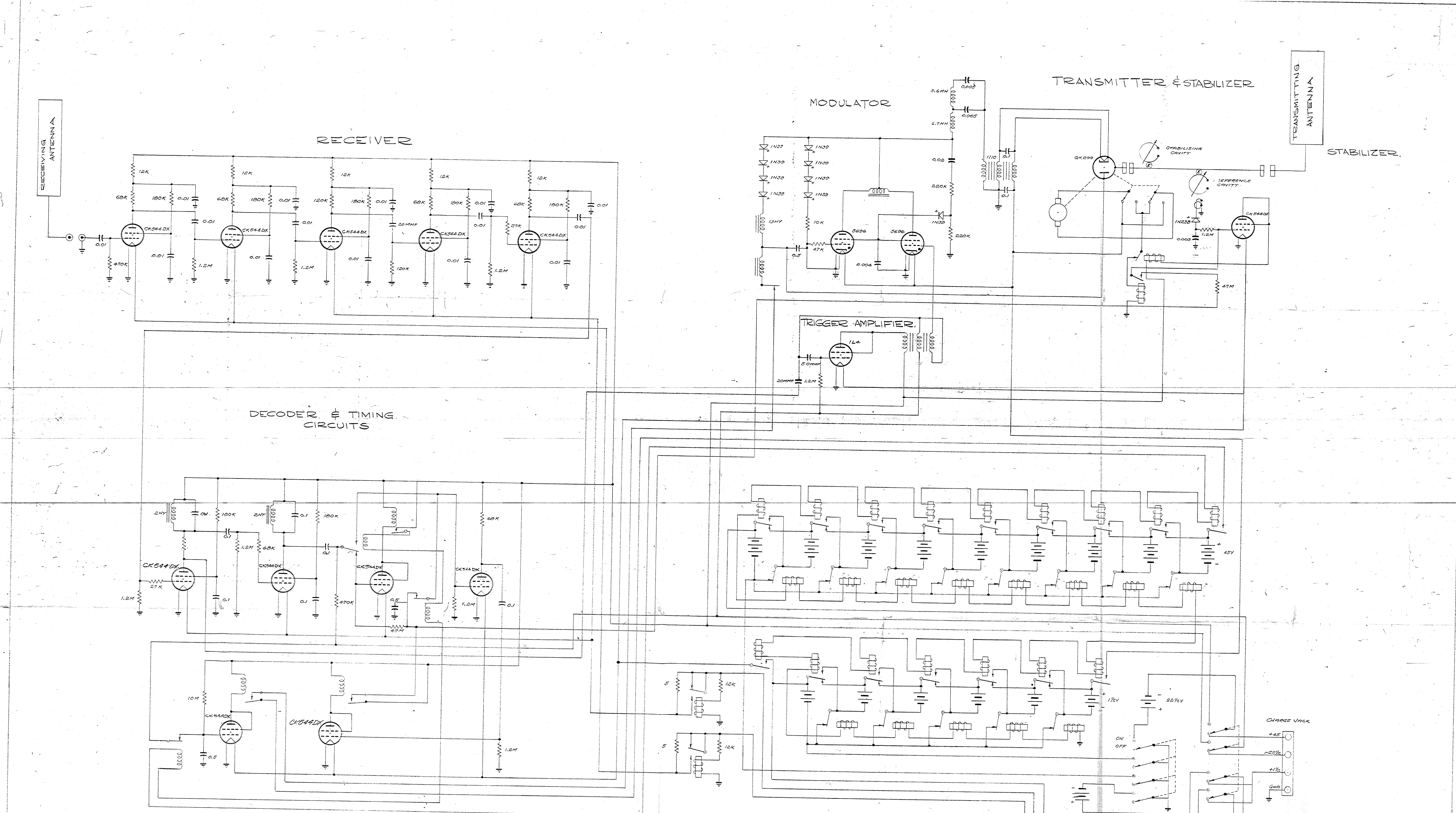

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MAR 23 1951

ISSUED TO

TOLERANCES UNLESS SPECIFIED	FRACT. DIM ±	DECIMAL DIM ±	ANGULAR DIM ± SCALE:
DRAWN 3.16.51 J. Shaughnessey	APPROVED	AIRBORNE INSTRUMENTS LABORATORY INCORPORATED 160 OLD COUNTRY RD. MINEOLA, NEW YORK	
CHECKED	ENG'R. P. Strom		
HEAT TREAT		TITLE Schematic	
FINISH			
MAT'L		NEXT ASSEM.	DWG NO. 827-5F3

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